

THE DISTRIBUTION OF *PILULARIA AMERICANA* A. BR. (MARSILEACEAE) IN NORTH AMERICA, NORTH OF MEXICO

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Pilularia americana A. Br., a member of the Marsileaceae, is an inconspicuous mat-forming aquatic fern with filiform leaves (2–6 cm long), creeping rootstocks, and globose sporocarps (2 mm in diameter) that are attached below the hydrosol (Small, 1964) (figure 1). According to Christensen (1905), it is one of six species in the genus and is known only from scattered stations in the New World.

Pilularia was first collected in North America by Thomas Nuttall from Fort Smith on the Arkansas River during his famous botanical foray of 1818–20. It was reported in his list of collected species without indicating a specific epithet (Nuttall, 1837). In 1864, Alexander Braun described the species *Pilularia americana* from Nuttall's collection (Small, 1935). Small (1935) indicated that although specimens collected by Nuttall are scarce, there is a specimen of his Arkansas collection of *Pilularia* at the New York Botanical Garden.

Additional collections of *Pilularia* were not made until the late 1800's and these were from California (Santa Barbara County, 1879; San Diego County, 1884) and Oregon (Lake County, 1894). The 1894 Oregon collection was originally reported from Crook County, but is now in an area included in Lake County (K. L. Chambers, pers. comm.). In 1935, J. K. Small reported a specimen collected in 1901 by collectors of the Biltmore Herbarium from Barrow County, Georgia, that had escaped mention in the fern literature (Small, 1935).

This report spurred McVaugh to attempt to rediscover the Barrow County population. In this he was unsuccessful, however, he did find specimens growing with *Isoetes* in pools on granite flat rocks in Walton County, Georgia (McVaugh, 1936), and in a muddy pond in Washington County, Georgia (McVaugh, 1943). LaMotte and a student accidentally collected sporocarps of *Pilularia* in 1934 from similar granitic habitats in central Texas (LaMotte, 1940). In the early 1940's, *Pilularia* was rediscovered in Arkansas and newly collected from Kansas. No further populations were known until the 1960's when it was reported from Oklahoma (Correll, 1967) and Nebraska (McGregor, 1967). This established the distribution of *Pilularia* in Arkansas, California, Oregon, Georgia, Texas, Kansas, Oklahoma, and Nebraska. Reports

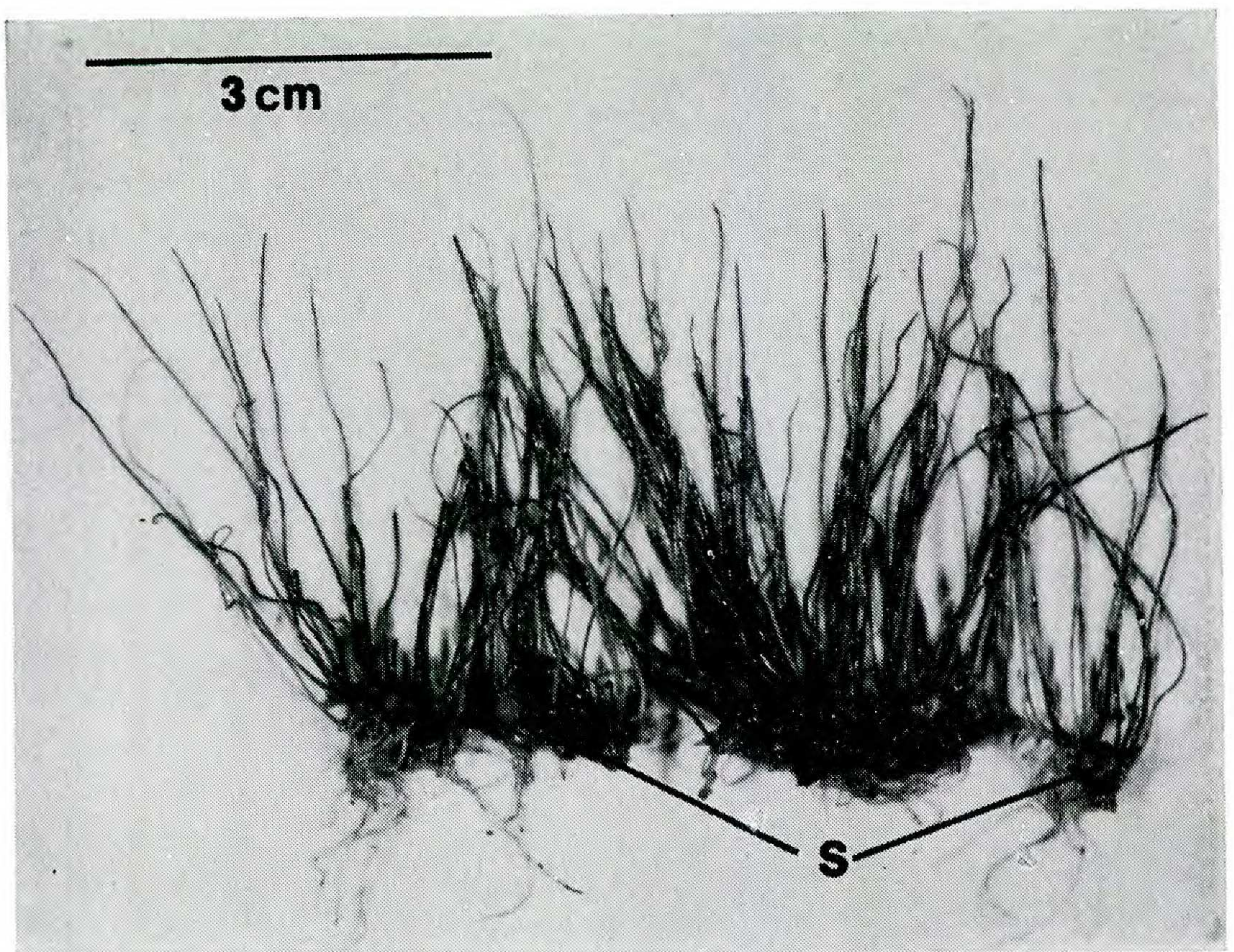


Figure 1. *Pilularia americana* with sporocarps (S).

of *Pilularia* from Louisiana (Correll, 1967) and Illinois (Mohlenbrock, 1975) were later found to be errors (Petrik-Ott and Ott, 1980; R. H. Mohlenbrock, pers. comm).

In June 1979, *Pulularia* was first collected in Tennessee from Dogwood Lake in Henderson County (Webb, Dennis, & Price, 2001, TENN, VDB). Later in August (A. J. Petrik-Ott, 1379 & F. D. Ott, US) and September (Dennis & Nakosteen, 2375, TENN), independent collections were made from Fall Creek Falls Lake in Van Buren County, Tennessee. The Van Buren population was reported by Petrik-Ott and Ott (1980).

In an attempt to define the known distribution of *P. americana* in North America, north of Mexico, 44 herbaria were consulted as to their holdings of this species. Thirty-two herbaria responded (see acknowledgements) and based on these records *P. americana* is known from 55 counties in nine States (figure 2).

These records indicate that *P. americana* is far more common in California than any other part of its range. It occurs in vernal pools throughout the State and has been collected in 39 of the 101 years since it was first discovered there. It is most often collected in April and May, but has been



Figure 2. Distribution of *Pilularia americana*.

found as early as March and as late as September. The Oregon populations are in counties adjacent to California in similar habitats.

In Arkansas, *P. americana* is found along margins of lakes in the Ozark region and in Oklahoma it is known from only three lakes in two counties. The Kansas and Nebraska populations occur in natural ponds of sandhill regions that are subject to desiccation (R. E. Brooks, pers. comm.). With the exception of the Washington County population which occurs in the inner coastal plain, the Georgia populations are confined to shallow seasonal pools on granite outcrops in the piedmont province. In Texas, this species also is confined to seasonal pools in areas of granitic outcropping.

The newly discovered Tennessee populations are in artificial lakes of recent origin (late 1960's), both of which experience some drawdown or lowering of the water level in the fall. The lakes are, however, in quite dissimilar physiographic regions. The Henderson County population is in the Mississippi embayment region of west Tennessee whereas the Van Buren population occurs on the Cumberland Plateau.

McMillan *et al.* (1968) conducted studies to determine what factors contributed to the limited distribution of *P. americana* in Texas. Their findings indicated that the "special niche" of *Pilularia* in Texas and perhaps the eastern U.S. may be attributable to the following:

(a) sporophytes that cannot withstand complete desiccation, (b) sporophytes that can withstand various levels of submergence, (c) sporocarp production stimulated by drying conditions, (d) sporocarp development under a range of photoperiod-temperature conditions, (e) sporophytes that are vegetatively inhibited by calcareous soils and vegetatively stimulated by granitic soils with pH of 5.2 to 6.5, (f) rapid germination of spores when exposed to moisture, (g) germination of spores over a range of temperatures and media, (h) inhibition of germination in submerged calcareous soils of pH 7.5–8.1.

It appears from habitat data from throughout the range of *P. americana* that the main requirement for this species is a semipermanent aquatic habitat. Historically, this type habitat has been limited to "natural" sites such as vernal pools, ponds subject to desiccation, and seasonally wet depressions on rock outcrops. More recently, however, with the multitude of manmade impoundments, most of which are designed for seasonal drawdown, habitat is being created for colonization.

McMillan *et al.* (1968) found *Pilularia* in newly created habitats such as quarries in the same vicinity of natural habitats in Texas. The Tennessee populations, however, indicate that *Pilularia* has the ability to colonize new habitats in areas much removed (>170 miles) from known populations. Dissemination to these areas is presumed to be attributable to waterfowl as has been previously suggested by McMillan *et al.* (1968). Also noteworthy at these Tennessee stations is the degree to which this species has become established. In 1979 the Henderson County population formed dense stands in the drawdown zone of Dogwood Lake and appeared to be outcompeting

Eleocharis acicularis. Although sterile, sporophytes of *Pilularia* from Dogwood Lake have been collected at depths of up to four feet during mid-summer prior to fall drawdown. In September 1979, when the lake at Fall Creek Falls State Park was four to six feet below maximum pool, *Pilularia* formed a monotypic stand from the normal water line to a depth of several feet for the entire length of shoreline that could have been seen from the dam.

The studies of McMillian *et al.* (1968) indicate that *P. americana* is restricted to slightly acidic semipermanent aquatic habitats. The recent discoveries of this species in Tennessee in artificially created habitats much removed from known populations suggest that it may be disseminated for some distance presumably by waterfowl and become successfully established. Due to its inconspicuous habit which could easily be confused with mats of *E. acicularis*, additional populations of *Pilularia* have probably been overlooked. The ability of *Pilularia* to rapidly and extensively colonize drawdown zones should make it a candidate species for management efforts on these often barren niches. Studies of this nature are underway.

ACKNOWLEDGEMENTS

The authors wish to express appreciation to Albert H. Price III for preparation of the figures and to the curators of the following herbaria for providing distributional data: ASTC, BAYLU, BH, BKL, CPH, DAV, DS, DUKE, FLAS, FSU, GA, GEO, GH, ISC, KANU, LA, LRU, MICH, NCU, NEB, OKLA, ORE, OSC, SACT, SFSU, SMU, TENN, TEX, UARK, UC, VDB, WTU.

LITERATURE CITED

- CHRISTENSEN, C. 1905. Index Filicum. Hagerup, Copenhagen. p. 495.
- CORRELL, H. B. 1967. *Pilularia americana* A. Braun in Oklahoma. Amer. Fern. Journ. 57: 31-32.
- LAMOTTE, C. 1940. *Pilularia* in Texas. Amer. Fern. Jour. 30: 99-101.
- MCGREGOR, R. L. 1967. *Pilularia americana* A. Braun new to Nebraska. Amer. Fern. Journ. 57: 136.
- McMILLAN, C., C. E. JENS, W. R. ADLER, R. V. BLYSTONE, W. H. GILLESPIE, J. R. IRWIN, R. E. JANOWSKY, D. O. KOLLE, T. S. PERRY. 1968. Factors influencing the narrow restriction of *Pilularia americana* in Texas. Southwestern Naturalist 13: 117-127.
- McVAUGH, R. 1936. A new eastern station for *Pilularia americana*. Amer. Fern. Journ. 26: 107-108.
- . 1943. The vegetation of the granitic flat-rocks of the southeastern United States. Ecol. Monographs 13: 119-166.
- MOHLENBROCK, R. 1975. Guide to the vascular flora of Illinois. Southern Illinois University Press, Carbondale and Edwardsville. p. 454.
- NUTTALL, T. 1837. Collections toward a flora of the Arkansas territory. Trans. Am. Phil. Soc. II. 5: 140.
- PETRIK-OTT, A. J. and F. S. OTT. 1980. *Pilularia americana* new to Tennessee. Amer. Fern. Journ. 70: 29-30.

- SMALL, J. K. 1935. *Pilularia* rediscovered in the East. Journ. N.Y. Bot. Gard. 36: 141-142.
- . 1964. Ferns of the Southeastern States. Facsimile of the edition of 1938. Hafner Publishing Co. New York. p. 385.